

# International Fragmentation and the New Economic Geography

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December 2003

In a recent magisterial survey, Peter Neary (2001) remarked that, “Economic Geography has come of age.” Several years later we are witnessing an extended birthday bash – a newly published volume by Richard Baldwin and associates (2003), and a forthcoming volume 4 of the *Handbook of Regional and Urban Economics*. Most of this literature pays special tribute to the pioneering article and book by Paul Krugman (1991a, 1991b), as well as Anthony Venables (1996), and the detailed book, *The Spatial Economy*, by Masahisa Fujita, Krugman and Venables (1999). This book pays special attention to the so-called Core-Periphery model laid out in the earlier Krugman contributions, and to the central issue in this body of theory, i.e. the phenomenon of agglomeration of economic activity. Much of the effort in newer articles and chapters, including the Neary survey, is devoted to coming to grips with problems presented by the core-periphery account. As Baldwin, *et. al.*, attest, “This model ..... has the unfortunate feature of being astoundingly difficult to work with analytically.” (2003, ch. 1, p.2).

In this paper we have no intention of adding to these efforts to make the new economic geography analyses more tractable, although we do empathize with the need to simplify the analytics of the issue. Instead, we discuss our alternative framework within which issues such as the agglomeration of economic activity can be understood. This work, starting with our original article in 1990, is supported by the emphasis placed in the theory of international trade on the increasing importance of trade in intermediate goods and goods in process. Such emphasis is reflected, of course, in the long-standing interest in foreign investment activity. Around four decades ago the importance of international trade in intermediates was recognized by the many contributions to the theory of effective rates of protection. This theory contributed the valuable insight that the production of final commodities often relied on

intermediates originating abroad, and that account of such trade should be taken in calculating the *effective* rate of protection to local productive activity provided by a country's tariff structure (e.g. Max Corden, 1966). In an era of intensive international tariff reductions, the theory of effective protection addressed a real-life issue: what is the essential meaning of reductions in tariff walls when industries are interdependent and interconnected in a global economy.

In the early 1980's the concept of *middle products* was introduced (Kalyan Sanyal and Jones, 1982, and Jones and Douglas Purvis, 1983) to incorporate the notion that almost all final commodities make use of a pair of inputs – those available in national markets and those obtained in world markets. Here again, a real-life phenomenon suggested a research agenda: When inflation became a truly international event, could countries insulate their economies from global influences? Traditional trade theory applied to open macro-economics seemed to be saying no, at least in the context of small countries under fixed exchange rate system which produced only tradable goods. And yet, inflation rates differed across countries, small and large, and even PPP did not hold particularly well.

The theory of trade in middle products suggested an explanation of the puzzle by postulating that productive activity within an economy could be separated into two *tiers* – an *input tier* wherein labor and natural resources locally found can be combined to produce goods *for* the world market, and an *output tier* that combines goods *from* the world market with local inputs to produce final consumer goods. That is, almost all of international trade takes place in the middle of the production spectrum. While prices of middle products may equalize across the world rather quickly and completely (and be exogenous for small countries), the prices of goods actually consumed need not be the same.

No short review of economic phenomena and trends encouraging research and leading to new trade theories or models would be complete without the intra-industry trade described and documented by Herbert Grubel and Peter Lloyd in the 1970s. Considered initially by some economists as a statistical artifact, intra-industry trade triggered a revolution in international trade theory. For our purposes it is important to note that intra-industry trade not only refers to final goods, such as different colors or makes of automobiles, but often parts and intermediate goods (middle products) as well.

The focus of our modeling on fragmentation of production processes is on the possibility of using services to break up a vertically integrated production nexus into separate fragments, which may be located nearby, in the same firm, or at some distance, perhaps in a different country and under the control of different firms. In our modeling efforts we have deliberately ignored the requirement that final produced goods must reach consumers. Instead, in keeping with the traditional paradigm of international trade theory, we have assumed that each country's labor force and consumers have their mobility limited by the national boundary and increasingly can easily be serviced by retail outlets and direct providers of services. This allows us to focus on the role of services in linking various fragments of the production process. In more modern terminology, we are stressing the importance of "B to B" activities rather than "B to C" ones. A recent article in *The Wall Street Journal* (November 20, 2003, p. B1), in discussing the users of online services, remarks that in the year 2002 consumers in the U.S. spent \$71 billion on goods and services online. This contrasts with U.S. businesses spending \$482 billion in online transactions with other businesses. Furthermore, by ignoring the costs involved in reaching the final consumer, a central concern in the economic geography literature, we avoid the analytical complexities introduced by focusing on consumer demand for variety. This love of variety is captured in the core-periphery models by the use of Dixit-Stiglitz (1977) utility functions, which leads at times to what Peter Neary refers to as "a near-impenetrable soup of CES algebra" (2001, p. 537). Emphasizing that consumers have a taste for variety served extremely well the analysis of intra-industry trade in "new trade theory", but perhaps does not as easily pass a cost/benefit test in the "new economic geography".

A crucial difference in the scenario found in the new economic geography models with that in our paradigm of the fragmentation of production processes concerns not the existence of increasing returns, but their location. In the core-periphery models and variants found in the new economic geography the love of variety embedded in consumer tastes is matched by a symmetric array of producers, each providing a different variety, with markets characterized by Chamberlinian monopolistic competition. In such equilibria the firm is still at a decreasing cost range of its average cost curve, and this is guaranteed by the assumption that for each firm costs are made up of a fixed cost element and constant marginal costs. (Thus the average cost curve never turns upwards). That is, increasing returns are internal to the plant and firm. Our fragmentation scenario rests on a distinction between *production blocks* and *service links*

(Jones and Kierzkowski, 1990). In the simplified version of the scenario production blocks may exhibit constant returns to scale. A production process consists of a sequence of such production blocks, which needs to be linked by the services of transportation, communication, and financial inputs. To these services must be added the general costs of co-ordination and the acquisition of relevant information. In the simplified version of our model these service link activities are assumed to exhibit the kind of strong increasing returns associated with fixed costs that are invariant to scales of output. This makes most sense with communication and co-ordination activities, but even transportation costs are usually declining with quantities transported. In any case it is in the service link sectors that we assume increasing returns are to be found rather than on the plant floor. And this difference leads to a significant reversal of the view often expressed in the new economic geography that increases in the level of economic activity are associated with increased spatial agglomeration of such activity.

The fragmentation paradigm is essentially a dynamic one. We do not attempt to explain why a particular country has the degree of agglomeration of productive activity it has inherited from the past. Instead, we ask what changes can be expected in the pattern of agglomeration by the steadily increasing trend in (i) levels of aggregate income and spending on particular goods, (ii) technological progress in the nature and costs of connecting service links as well as deregulation of service activities both nationally and between countries, and (iii) developments of new technologies for production blocks and the introduction of new products. We take as given that skill levels and productivity of factors of production and other inputs may differ widely from country to country as well as within regions of the same country. Differences in factor endowments and in country regulations and tax patterns often account for the variation in returns to factors found among the global array of nations.

Consider a particular final commodity. It could be produced in a vertically integrated process, with all activity taking place in one locale. However, the total costs of producing output might be lowered by outsourcing some *fragment* of the integrated activity, say one that makes relatively intensive use of unskilled labor, to another locale in which labor productivity is higher relative to its wage rate. This calls to mind the possibility of increasing returns suggested by Adam Smith, who pointed to the advantages of a division of labor (that was limited by the extent of the market). Such a geographical separation of production fragments introduces the necessity of establishing service links in the form of transportation,

communication and other coordinating activities. It is the costs of these service links that we assume do not rise in proportion to levels of output, and in the simple version of our model we assume these costs are fixed. For example, the communication costs of establishing a shipment of one thousand units may be the same as that for ten thousand units. Transport costs, of course, are another matter. These play center stage in models of the new economic geography, and the assumption typically adopted there is that of the “iceberg” variety (suggested by Samuelson, 1952), wherein the “melting” of the product being shipped reflected a constant fraction of the amount being transported. (Much earlier, von Thunen suggested that horse-drawn hay was in part consumed by the means of transport). However, it is widely recognized that costs per unit of the item being transported usually decrease with volume. If the extra costs of service link activities are more than balanced by the lower marginal costs obtained by a closer match of factor intensities with net factor productivities for each fragment, such outsourcing will take place in order to minimize costs of production. For a given degree of fragmentation the nature of service link activities leads to a lowering of total average costs of production with output. However, further increases in output may suggest a finer degree of fragmentation of the production process, with the extra costs of connecting service links now more than matched by the lower assembled marginal costs of the production blocks. In the aggregate average costs of production decrease with output for a given pattern of fragmentation, and *marginal* costs of total production are lowered discontinuously at the point at which the degree of fragmentation is increased (Jones and Kierzkowski, 1990).

Figure 1 is the kind of diagram we have frequently used to illustrate the growth of fragmentation when incomes and demand for output of a product increase. Ray 1 from the origin reveals what the costs of production would be if undertaken in a single production block exhibiting constant returns to scale, while line segment 2 with vertical intercept  $OA$  suggests an alternative process whereby two different domestic locations are selected to take advantage of geographic differences in various factor costs and productivities. The choice of these two locations lowers aggregate marginal costs (shown by the slope of  $A2$ ), but their co-ordination requires service links that are shown by fixed costs,  $OA$ . Such fragmentation only becomes cost-effective if output levels exceed  $OD$ . Line segments 3 and 4 illustrate the increasing possibilities of decreasing marginal costs if a greater degree of fragmentation is introduced with foreign sources enlisted in order to take advantage of differences in international factor

prices that lower costs because of differences in factor requirements among the separate fragments. Of course, such international fragmentation raises the costs of connective service links. The integrated minimum cost schedule is shown by the heavy locus, with increases in the degree of fragmentation occurring at output levels D, E, and F. This schedule exhibits increasing returns to scale.

The role of international trade is crucial in this description. Although fragmentation can, and often does, take place within a region or country, it is not limited by national boundaries. The costs of connective service links may be larger in supporting a production network that encompasses more than one country, but the pay-off in lowering aggregate production costs by taking advantage of a wider spread of effective factor costs between, as opposed to within, a country encourages this broader spread. In this regard the modeling strategy typically found in the new economic geography, wherein varieties of goods produced may have different appeals to consumers but are “horizontal” in their similar use of factors in production, makes little use of the commonly found wide disparity in factor returns among nations. By contrast, such a wide disparity plays a central role in international fragmentation. Furthermore, it is the fragmentation possibility inherent in each variety that would be of interest in our model.

In recent decades we have witnessed great productivity improvements in the costs of providing connective service links. Perhaps foremost is the reduction in costs of communication practically to the vanishing point. Telephone costs have, of course, been reduced dramatically, with reductions in relative costs in international communication even greater than that within countries. The introduction of Fax technology, and then the widespread adoption of e-mail transmission and the ability to send moving images (in color) from one part of the globe to another instantaneously has done much to facilitate broader international fragmentation and production networks. Figure 1 reveals how reductions in the costs of service links promote greater degrees of fragmentation for any given output level. At an international level this reflects the close positive association between lower service link costs and dis-agglomeration or dispersion of productive activity. In a recent manuscript (Jones and Kierzkowski, 2003) we illustrated in a pair of simple diagrams how greater levels of output encouraged such dispersion in the fragmentation scenario, although if increasing returns are centralized on the factory floor, and service link costs consist only of “iceberg” type of

transportation costs, greater output levels might well support greater levels of agglomeration. These paradigms lead to significantly different results.

The reduction in service link costs has also been aided by moves to de-regulate such activities, both within countries and, as in the efforts of the Uruguay Round of GATT talks, internationally. One of the misplaced concerns of less developed areas during these negotiations is, in our view, that these areas do not have a comparative advantage in providing services and thus would lose out by a freeing-up of services. Such a stance overlooks the fact that a lowering of costs for service link activities makes the production of fragments more possible for such countries. For example, a recent study (Ng and Yeats, 2003) points out that in East Asia from 1990 to 2001 the exports of parts and components to countries outside the area increased from nearly \$56 billion to almost \$118 billion, with an even greater rise for exports within the East Asia region from almost \$34 billion to \$110 billion, an almost three-fold increase. Furthermore, technical progress has also encouraged fragmentation *within* the service sector. The use made by businesses in Silicon Valley of software services provided many time zones away by personnel in Bangalore has been widely documented. Even local consumers in the United States may use the telephone to make travel arrangements for locales within the country and end up talking with service personnel in Jamaica or India.

Technical progress also takes place within production blocks. Frequently this is a concomitant of changes in the quality of the commodities being produced or, indeed, of introducing new commodities in which the optimal choice of technique has yet to be developed. This is the context in which Ray Vernon's (1966) theory of the *product cycle* was set. He considered the geographical pattern in which a new commodity is at first produced in a developed country such as the United States and, after a sequence of trials with different technologies, simple methods of production are discovered that cause a shift in the pattern of comparative advantage: Less developed countries take over production that has become quite labor intensive. Key to the early part of the cycle is the existence of a wide variety of human and physical capital and skills in the developed country at a time when there is uncertainty about the techniques that will evolve. This bears some resemblance to the assumption about production adopted by Wilfred Ethier (1982) in his reinterpretation of the Dixit-Stiglitz utility function as a production function wherein productivity is an increasing function of the variety of skilled inputs available. Such a reinterpretation for production has been used in the new

economic geography literature. In Vernon's hands it explains a sequence whereby there is a continual outsourcing of production towards less developed areas as techniques simplify, accompanied by ever-emerging new products and technologies being developed in advanced areas. Such a view holds as well for fragments of a technology that become quite labor intensive.

One of the most basic features of a country being able to engage in international trade is that it cuts the dependence of local consumption upon a matching wide range of local production. Trade allows a great degree of concentration of productive activity, so that any changes that reduce the cost of trading, whether natural or man-made, can be expected to lead to greater degrees of concentration of productive activity, often in urban areas with good port or rail facilities. Therefore it is natural to associate an agglomeration of economic activity *nationally* with increases in levels of international trade. However, at an *international* level increased trade, especially when accompanied by greater levels of international fragmentation of production, is reflected in a global dis-agglomeration or dispersal of productive activity. Less developed countries that have little basis in comparative advantage in producing manufactured goods when production processes must be vertically linked in one place and one time can increasingly join in producing fragments of these processes when increasing returns associated with service link activities allows a lowering of costs by outsourcing labor-intensive fragments. In other words, trade and fragmentation may lead both to an increased dispersion of production activity world-wide while simultaneously encouraging national agglomeration.

We have argued that international fragmentation is best seen in a dynamic context. Apropos of the agglomeration issue, it is possible to argue that increases in the outsourcing of economic activity, whether nationally or globally, may lead to new forms of agglomeration. Production processes when compared across industries often have separate fragments that are more similar from one industry to another than is the integrated whole. That is, fragmentation sometimes encourages a horizontal spread wherein the similarity between fragments across industries encourages technological progress to make fragments even more similar and thus to encourage new forms of agglomeration (Jones and Kierzkowski, 2001). Consider the outsourcing of accounting activities to new firms that may service many sectors. Or, perhaps the most cited case, the use of computer chips not only in computers but also in toasters, laser devices, and in countless productive activities in many industrial sectors.

Most new economic geography models have the perceived advantage (compared with the literature on fragmentation) of explicit modeling of imperfect competition. Typically firms are in markets characterized by monopolistic competition. The emphasis in the consumption side on the existence of variety in the utility function is matched by the variety of goods produced, each one by a different firm in the monopolistically competitive equilibrium. As already noted, the imposition of identical technology for each variety serves to make international differences in productivities and factor prices of less importance in the determination of the geographical pattern of production. By contrast, such a wide range globally in the components of production costs is central to the discussion of international fragmentation. Global dispersion is precisely what is encouraged by the increasing returns from service sector activities. Although it foregoes the assumption of horizontal variety among commodities, the fragmentation literature does exhibit a different kind of variety – among a number of possible forms of market competition. For example, production blocks could be undertaken by purely competitive firms, on the one hand, or by large multinational firms, on the other. These firms may keep control over many of the production blocks for a commodity, and even for some of the service links. However, greater outsourcing to independent firms may be encouraged by a greater knowledge they possess of foreign market conditions, a higher density of foreign suppliers which makes “hold-up” less a danger, and less uncertainty about getting on-time delivery of fragments necessary for final assembly. Some service link activities, such as telephone or transportation, may be undertaken by oligopolistic producers, but in world markets in which technology is constantly changing, competition can easily encourage a cap on prices. Other coordinating activities, such as involved in connecting several fragments in less developed areas, may be undertaken by small organizations that again are subject to strong competitive forces. Whatever the nature of the organization of firms, in the global market place firms are constantly aware of potential or actual suppliers of similar services or products in a competitive fashion. Furthermore, the extreme assumptions embodied in Figure 1, *viz.* that constant returns prevail within production blocks but for service links costs are strictly invariant with respect to increases in outputs, can be moderated to allow some increasing returns on the factory floor and some degree of positive marginal costs in providing connective service links.

New economic geography models are becoming popular and indeed can provide much insight about issues concerning the agglomeration and spatial location of economic activity. But, like the huge elephant that is being viewed from different perspectives by different observers, the fragmentation paradigm also has much to offer. In a world in which advanced countries are witnessing a reduction in manufacturing activity and a great increase in services, and in which international trade in parts and components is increasing at a significantly higher rate than trade levels generally, much understanding may be gleaned from simple models that stress the importance of service links that provide increasing returns to production processes that spread fragments of the process over several nations.

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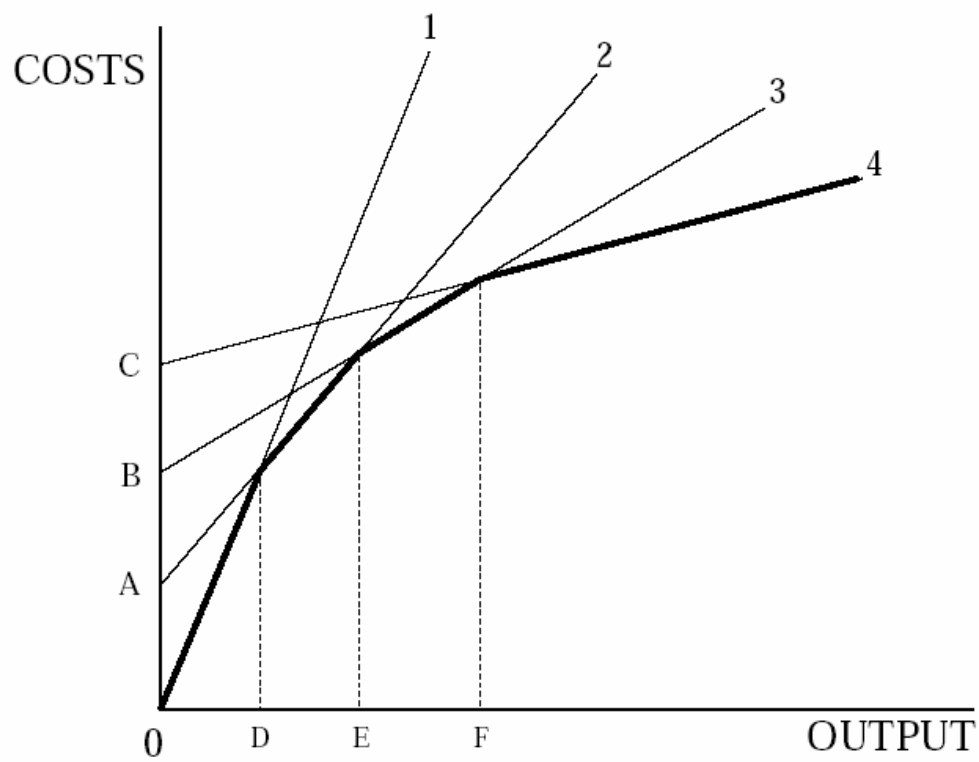


FIGURE 1